Popular Astronomy.

Vol. XXXIV, No. 3 MARCH, 1926 Whole No. 333

REPORT ON MARS, NO. 34.

By WILLIAM H. PICKERING.

The Apparition of 1924.

Opposition occurred on August 23, when the diameter of the planet was 25″.11, and the solar longitude ☉ 242°.6, corresponding to M. D. November 25. It was slightly nearer to us on the previous day, but the difference in its diameter was less than 0″.01. The winter solstice, with the revised position of the polar axis based on our measures, which will appear shortly in the Harvard Annals, Vol. **82**, fell on September 24, Martian Date December 1. Since the southern hemisphere was turned towards us, it was therefore the summer season of the greater portion of the visible surface. At this apparition the planet approached nearer to the earth than had been the case at any time during the last century, and nearer than it will be again before 2000 A. D. For practical purposes, however, it comes as near to us once every sixteen years, or more accurately speaking at intervals sometimes of fifteen, and sometimes of seventeen years, when its diameter reaches 24″, or within 4 per cent of its diameter in 1924. Owing to its promised proximity, more interest was felt in the planet by the public, and perhaps as a result, we have a better set of drawings to select from this year, than at any previous apparition since the Society of the International Associated Observers of Mars was founded. Owing to the exigencies of publication it is possible to present in this Report only four series of drawings, but the others will appear a little later in the year. In another Report we shall also give the usual statistics of visibility of both the canals and lakes, as determined from the drawings of all the observers.

As in our Reports pertaining to the five previous apparitions, the drawings will be arranged in the order of the longitudes of the stations from which they were obtained. Since we have no European observers this year, the Jamaica drawings will be considered first. The designations, localities, and equipment of the various astronomers who reported are as follows:

P Professor W. H. Pickering, Mandeville, Jamaica, B.W.I. 11-inch refractor by Clark. Magnifications employed 300 and 430. Seeing on the Standard Scale ranging from 8 to 12.

H G. H. Hamilton, Esq. Same address, same instrument, magnification 300 and 430. Seeing on the Standard Scale 7 to 11.

W L. J. Wilson, Esq. Nashville, Tennessee. 11-inch reflector made

PLATE I.

Fig. 1
Pickering 358° A

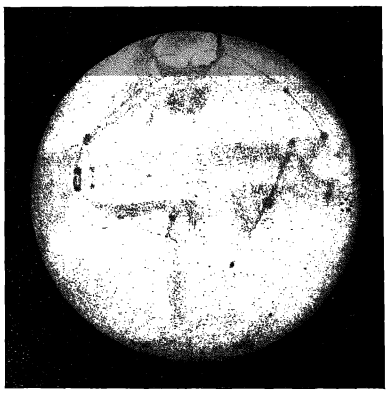

Fig. 2
Hamilton 1° A

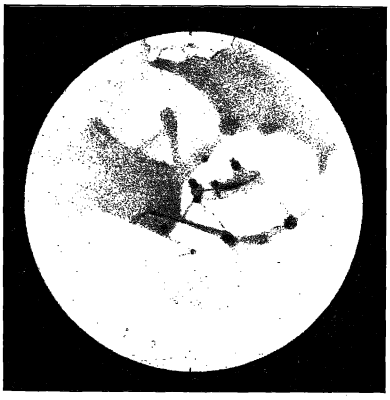

Fig. 5
Pickering 60° B

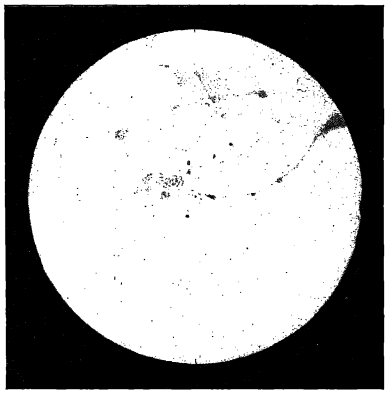

Fig. 6
Hamilton 67° B

Fig. 9
Pickering 118° C

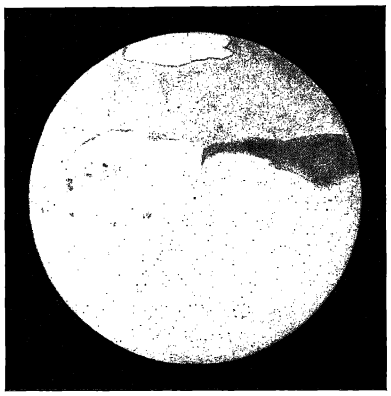

Fig. 10
Hamilton 122° C

DRAWINGS OF MARS IN 1924.

POPULAR ASTRONOMY, No. 333.

PLATE II.

Fig. 3
Wilson 2° A

Fig. 4
Trumpler 343° A

Fig. 7
Wilson 54° B

Fig. 8
Trumpler 69° B

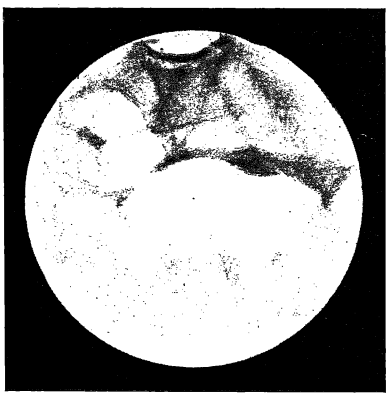

Fig. 11
Wilson 128° C

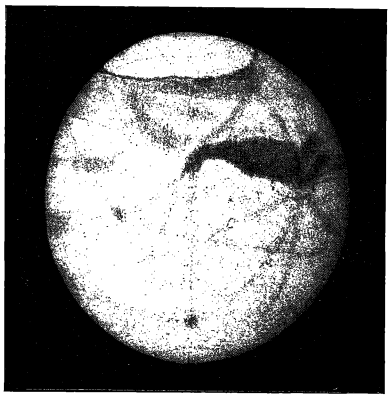

Fig. 12
Hamilton 120° C

DRAWINGS OF MARS IN 1924.

by himself. Magnifications 360 and 400. Seeing on the Standard Scale 8.

T Dr. R. J. Trumpler, Mt. Hamilton, California. 36-inch refractor by Clark. Magnifications 270 and 350. Seeing 2 to 4 on a scale of 5.

Description of the Drawings.

As in our former Reports, the drawings of the observers are so arranged that all in the same horizontal row shall represent approximately the same longitude on the planet. In the vertical columns the longitudes are intended to differ by just 60°, beginning with longitude 0°. Thus six views of the planet are shown by each observer, covering the whole visible surface. The six regions are indicated by the letters

TABLE I.

Fundamental Data of the Figures.

Fig.	Obs.	Apr.	Mag.	Sng.	1924	Reg.	Long.	ΔLong.	Lat.	Diam.	☉	M.D.
							°	°	°	″	°	
1	P	11	430	11	Aug. 28	**A**	358	— 2	—16	24.9	245.7	Nov. 29
2	H	11	340	11, 9	Sept. 2	**A**	1	+ 1	—16	24.4	249.0	Nov. 35
3	W	11	360	8	Aug. 30	**A**	2	+ 2	—16	24.8	247.0	Nov. 31
4	T	36	270	(3, 2)	Sept. 7	**A**	343	—17	—16	24.0	252.0	Nov. 39
5	P	11	430	10, 12	Aug. 22	**B**	60	0	—16	25.1	241.9	Nov. 24
6	H	11	430, 300	8, 10	Aug. 26	**B**	67	+ 7	—16	25.1	244.6	Nov. 28
7	W	11	360	8	Aug. 27	**B**	54	— 6	—16	25.0	245.1	Nov. 29
8	T	36	350	(4)	Aug. 29	**B**	69	+ 9	—16	24.9	246.4	Nov. 30
9	P	11	430, 330	10	Sept. 22	**C**	118	— 2	—17	21.4	261.5	Nov. 54
10	H	11	300	7, 8	Aug. 22	**C**	122	+ 2	—16	25.1	242.0	Nov. 24
11	W	11	360	8	Aug. 21	**C**	128	+ 8	—16	25.1	241.3	Nov. 23
12	(H)	11	430	7, 8	July 13	**C**	120	0	—18	19.8	216.9	Oct. 40
13	P	11	430, 300	11, 10	Aug. 12	**D**	178	— 2	—17	24.6	235.6	Nov. 14
14	H	11	430	7, 9	Sept. 19	**D**	181	+ 1	—17	21.9	259.7	Nov. 51
15	W	11	360	8	Aug. 13	**D**	175	— 5	—17	24.7	236.3	Nov. 15
16	T	36	270, 350	(3)	Sept. 21	**D**	207	+27	—17	21.6	260.9	Nov. 53
17	P	11	430, 300	8	Aug. 5	**E**	244	+ 4	—18	23.8	231.3	Nov. 7
18	H	11	430, 300	8	Aug. 7	**E**	240	0	—17	24.1	232.5	Nov. 9
19	W	11	360	8	Aug. 8	**E**	239	— 1	—17	24.2	233.0	Nov. 10
20	T	36	270	(2, 3)	Sept. 15	**E**	252	+12	—16	22.7	257.1	Nov. 47
21	P	11	430	12	Sept. 5	**F**	300	0	—16	24.2	250.8	Nov. 37
22	H	11	340	8, 10	Sept. 8	**F**	300	0	—16	23.8	252.8	Nov. 40
23	W	11	400	8	Aug. 2	**F**	304	+ 4	—17	23.4	229.2	Nov. 4
24	T	36	270, 350	(3)	Sept. 11	**F**	300	0	—16	23.4	254.6	Nov. 43

A, **B**, **C**, **D**, **E**, and **F**. In Table I is given a statement of the main facts relating to the various drawings. The Table is arranged as in previous Reports, the successive columns giving the number of the figure, the designation of the observer, the aperture of his instrument, the magnifications employed, the seeing on the Standard Scale, which is described in Report No. **9**, the date of the drawing, the region depicted, the longitude of the central meridian, its deviation from the desired standard, the latitude of the center of the disk, the angular diameter of the planet, the longitude of the sun as seen from Mars, as described in the Ephemeris, and the corresponding Martian Date, taken from Report No. **10**.

The average date of the drawings was August 26, or three days

after opposition. In 1914 the average date coincided with the opposition, in 1916 it was 5 days later, in 1918 it was later by 15 days, and in 1920 and 1922 by 19 days. Whether these changes are due to a difference in the personnel at the different apparitions, or to a difference in their enthusiasm, or to alterations in the declination and proximity of the planet, or finally to a difference in the planet itself is uncertain. It may be that after the oppositions of 1918, '20, and '22 the planet really showed more detail, and better drawings were secured than at the opposition itself, while the contrary was perhaps the case in 1914, '16, and '24.

Discussion of the Drawings.

What is very surprising in Dr. Trumpler's work is the low magnification which he used. A low magnification gives strong contrasts, but his eyesight must be very acute if he can see everything with it, especially the shapes of the smaller markings, as well as he could had he used a higher power. That he failed to see some rather obvious markings in the polar cap was probably due either to the fact that that region did not interest him, or that his eye was dazzled by the enormous light gathering power of the great telescope. He writes that he could not readily stop the aperture down to a smaller size, as has been found desirable by all other planetary observers who have had the opportunity to use large apertures. Had he been able to do so, however, to perhaps 20 inches, the writer is convinced not only that he would have seen even more canals and lakes than he did, but that they would have appeared to him of as small a size as some of them did to us here in Jamaica.

Unfortunately he made no drawing of region **C**, longitude 120°, but Mr. Hamilton, whose drawings most resemble his, has kindly contributed one of his own drawings made in July, which probably shows about the same canals that Dr. Trumpler would have shown had he made a drawing of this region. By this plan we are able to compare his work with that of the other observers. Dr. Trumpler has also forwarded a letter, which he wishes to have published, explaining his method of work. We are glad to do this, and would call particular attention to his statement that when he made the drawings, he was entirely unfamiliar with the map of the planet. This fact vastly enhances the value of his drawings, because on them he shows a number of well known narrow equatorial canals not recorded by any other observer at this apparition. This indicates not only the excellent seeing on Mt. Hamilton, but also the advantage that he possessed in detecting very delicate canals due to his larger aperture. Furthermore he shows several canals occurring in unexpected places, canals which seem entirely at variance with the general system of distribution which we have learned to expect to find upon that planet. Now it happens that these particular unusual canals were also recorded by Dr. Lowell in 1909, and drawn upon his globe, but never published by him.

Dr. Trumpler's letter is as follows:

COMMENT ON FIVE DRAWINGS OF MARS.

"Originally it was intended to make an effort at obtaining photographs of Mars with the 36-inch refractor of the Lick Observatory during the opposition of 1924. When the first experiments proved successful the scope of the program was enlarged so as to furnish material for drawing a detailed chart of the planet up to the northern latitude limit of this opposition. Between the time occupied with taking photographs the telescope was available for visual observations. In view of the fact that the telescope was assigned to the Mars work only part of the time, and that this time had to be divided between measures of the Satellites and physical observations, it was important to use the available periods of fair or good telescopic definition to best advantage. Since the positions of the principal surface markings, the outlines of the dark and light regions on Mars, as well as the different grades of shading, could in all cases easily be obtained from the photographs, it would have been unnecessary duplication to follow the usual procedure of making complete drawings at the telescope. The short time seemed better employed in devoting it entirely to the study of the more difficult details that were likely to be missing or incomplete on the photographs. Considerable time was often spent trying to catch a certain detail repeatedly at the moments of best definition, and most of the drawings made at the telescope are incomplete detail sketches.

"The five drawings, of which three have been previously published in *Publ. A. S. P.*, **36**, 263, were each made a few days after observation in order to try how the combination of photographic and visual observations would work. The outlines of the dark areas, the positions of the principal markings, and the relative intensities of the shadings were drawn according to enlarged positives of a set of photographs, while the details were drawn in from a sketch made on the same evening immediately before or after the photographs. Each drawing therefore represents essentially the features of one single sketch. It should further be stated that the sketches selected for the five drawings were the first made of this peculiar part of Mars. The observer had never before observed Mars in a large telescope and purposely did not study other persons' drawings in detail, so as to keep an entirely unbiased judgment. These sketches were therefore made as of a new and unknown configuration except for that part that was overlapping with one of the previous sketches. Under these circumstances it is well possible that some details may have been omitted which could have been seen if looked for.

"The main value of these drawings probably lies in the fact that they were made without any previous knowledge of the configuration, but they are probably far from showing everything visible in the 36-inch refractor under favorable circumstances. In fact the chart prepared from the complete material of photographic and visual observations during the five weeks' period following opposition gives a great deal more detail than any of these first drawings.

DATES OF THE PHOTOGRAPHS ON WHICH THE DRAWINGS ARE BASED.

	Gr. M. T.		
1924	Aug. 29.81	$\lambda = 69°$	Sketch made after photograph
	Sept. 7.79	343	after photograph
	Sept. 11.77	300	between two photographs
	Sept. 15.74	252	after photograph
	Sept. 21.76	207	after photograph

(On September 11 the mean of the two photographs was used for the drawing.)"

We shall be much interested to see his chart when it appears. It is of course a fact that everyone's complete set of drawings shows more canals than the six best ones of particular regions that they have selected for publication. This is due to various causes, chiefly to changes occurring upon the planet, causing some canals to appear, and others to disappear. These changes are due partly to the development of the vegetation itself, in part to local showers occurring at night and bringing out certain detail, and partly to clouds or haze. Thus certain canals may appear with a given central meridian ω, which are not visible either a little earlier or a little later in the same Martian day. Sometimes a canal is visible for only a few days during the whole apparition. As illustrating these statements it appears that, although using the same instrument, Hamilton's six drawings show a number of canals confirmed by others but not found on mine, and similarly my drawings show a number of confirmed canals not seen by him.

While it is probable that all observers see the more distinct canals very much alike, yet it is certain that in some cases they represent on paper what they see very differently. Perhaps the most striking case among prominent observers was that of Lowell, who had a marked tendency, probably on account of his adoption of the irrigation theory, to represent every canal that he saw, no matter what its width, by a fine straight line. Later he modified his sketches, especially by giving more curvature to those canals occurring near the limb, but he never got over making most of them straight, and of nearly the same width. A comparison of his work with that of the drawings made at this past apparition is very striking in this last respect. When well seen, the canals are of every degree of width, from the narrowest visible, up to over a second of arc at a near opposition. Another striking exception to the general rule of observers is Maggini, who dots his canals with innumerable lakes. This I understand is in deference to his theory that the canals are not in reality uniform lines, but consist of a series of irregular spots.

But even among observers conforming to the same general rules of representation, there are notable differences. Hamilton's early training was at the Lowell Obervatory. Whether it is due to that fact or not, and he thinks not, he in most of the six regions draws the canals distinctly narrower than the other observers. In regions **B**, **C**, and **F** I often agree with him, but in regions **D** and **E**, where the canals have always seemed to me wide, I agree better with Trumpler and Wilson.

This is especially true in the darker parts. Here I also agree with Douglass. In the lighter portions of these regions I see faintly shaded areas in place of the very narrow canals seen by the others. The boundaries of these shaded areas appear to coincide with their canals. This furnishes what is perhaps an interesting case of two Martian observers, each of considerable experience, using the same instrument, under similar conditions, and yet representing what they see of the more difficult detail quite differently. Of course the general features and the more marked canals are practically identical.

In those instances where a canal forms the boundary of a slightly darkened region, and Hamilton sees the canal sharply defined on both sides, while I do not, the drawing has a distinct bearing on the general question of the actuality of the duplication of the canals. It would seem to explain why he sometimes sees double canals, where I see only single ones. He sees four edges to the canals while I see only two. He shows two duplications in each of the regions **A**, **D**, and **F**, but in only one case this year are the components strictly parallel, and also in only one case, Pandora, is the duplication confirmed by another observer, Trumpler. While the writer has seen several wide duplications and several narrow ones at former apparitions, the wide ones he attributes generally to accidental arrangement, and as far as the narrow ones are concerned, he is not certain of their objective reality, although open to conviction by future results.

ARYN.

This marking has interested us on account of the importance attached to it by some of the earlier observers, and its visibility has been discussed in several of our earlier Reports. We have now been able to follow the planet through practically the whole of its year, and are thus able to note the effect of the progressive seasons upon this marking. When the planet's diameter is over 10″, so that it can be well seen, the region of Aryn always presents to me one of three very distinct appearances.

(*a*) The so-called two bays of the Furca are united into a single triangle of varying shape, Aryn itself being invisible.

(*b*) The two bays unite to form a quadrilateral, their northern side lying in a nearly east and west direction, but varying its azimuth slightly from time to time. Occasionally the northern side is very slightly concave towards the south.

(*c*) Aryn appears as a well marked shallow notch in the quadrilateral, or sometimes as a deep notch dividing it into two distinct triangular bays. This notch occasionally extends as far south as the latitude of the southern coasts of Edom and Thymiamata.

During November and December of 1913, after ☉ 344°.5, M. D. February 27, the triangular form (*a*) was continually presented. During 1914, '16, '18, and '20, until June 2, 1922, ☉ 167°.0, M. D. September 13, the quadrilateral form (*b*) prevailed, with occasional relapses in-

to the triangular shape (*a*). With the approach of the equinox, clouds drifting over from the north caused the northern side of the quadrilateral on the latter date to become faint and hazy, and a suspicion of notching was presented. This had entirely disappeared by M. D. September 44 and 45, but the next day, ⊙ 186°.1, a small but distinct notch was certainly seen. On M. D. September 48 this had again disappeared, the quadrilateral appearing as before, but September 49 at central meridian ω 330°.6 a shallow notch was distinctly visible. The diameter of the planet at this time was 19″.2 and the seeing 11, so that the conditions of observation were very favorable. Two hours later at ω 3°.0 the notch was marked and very deep, extending nearly to its maximum depth. The next day September 50 it had disappeared, and was still missing September 51 and 53, when on both dates the seeing was marked 11. After this we lost sight of it until the next presentation. As a shallow notch Aryn was then visible with one exception on every day of its visibility which occurred in our August. The following month, ⊙ 231°.8, M. D. November 8, it had vanished amidst the rush of cloud and vapor travelling back to the northern hemisphere. A month later this had overwhelmed the Furca also. The striking meteorological phenomena visible at this time will be described and illustrated in a future Report.

There is no question in my mind but that Aryn itself is simply a cloud formation of varying size, shape, and intensity, which after the autumnal equinox of the planet occupies a portion of the middle of the valley of the Furca. Occasionally it reaches well up to its center, but often merely occupies a portion of the northern end. Several Martian observers claim to have seen it faintly marked practically throughout the Martian year, but to my eye Aryn is either very conspicuous as a bright region against the dark background of the Furca, or else it is not visible at all. There is no half-way condition.

In April 1924, ⊙ 164°.8, I could see no trace of Aryn, but the next month, ⊙ 181°.1, M. D. September 38, a small but distinct notch had appeared. Hamilton confirmed this, but a few days later drew Furca with no notch visible. Aryn appeared to the best advantage in July and August, ⊙ 226°.9 to 300°.2, M. D. October 55 to November 37. In the later observations it had shifted well to the east of the central line of the valley, so that the preceding bay was but one-third the width of the following one. During this year it was well seen until ⊙ 291°.9, M. D. December 46, but after that as before, it disappeared in a darkened area of precipitated moisture. We thus have a difference in these two successive Martian years of eleven weeks in the disappearance of Aryn, and of seven weeks in the disappearance of Furca, thus indicating very clearly the extraordinary variability of the Martian weather.

A Curious Terminator Formation.

On the evening of October 20, 1924, an interesting cloud effect was noted on the terminator over Hellas. I had made an early drawing of

PLATE III.

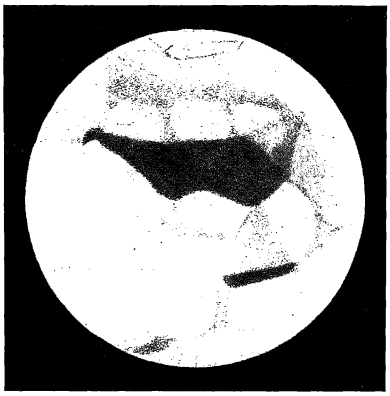

Fig. 13
Pickering 178° **D**

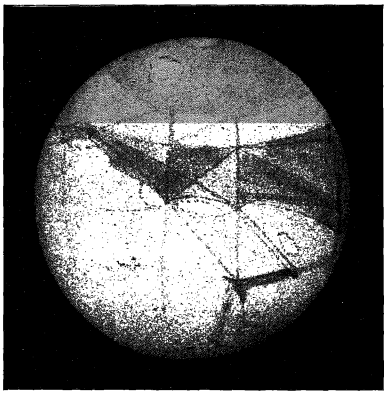

Fig. 14
Hamilton 181° **D**

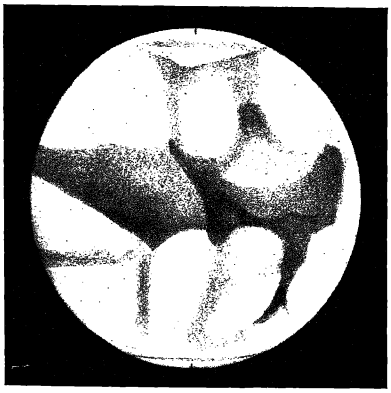

Fig. 17
Pickering 244° **E**

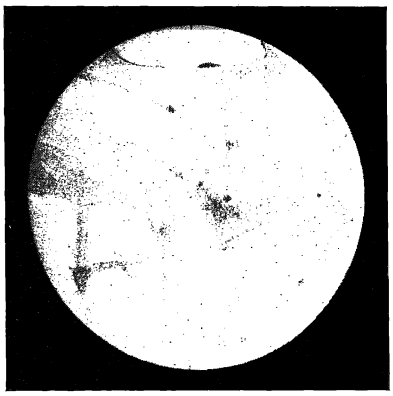

Fig. 18
Hamilton 240° **E**

Fig. 21
Pickering 300° **F**

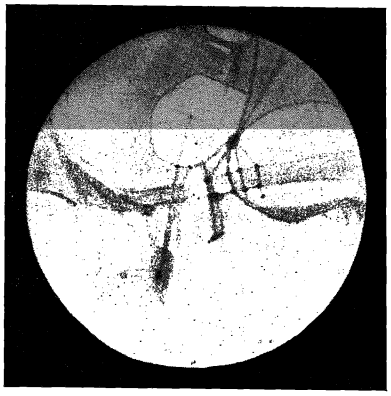

Fig. 22
Hamilton 300° **F**

DRAWINGS OF MARS IN 1924.

PLATE IV.

Fig. 15
Wilson 175° D

Fig. 16
Trumpler 207° D

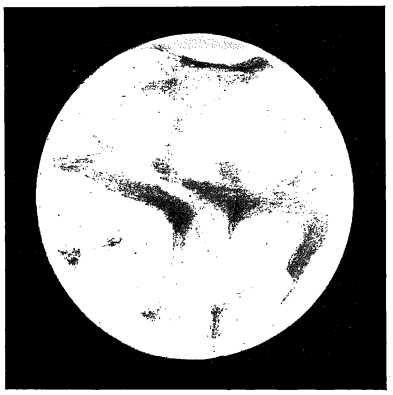

Fig. 19
Wilson 239° E

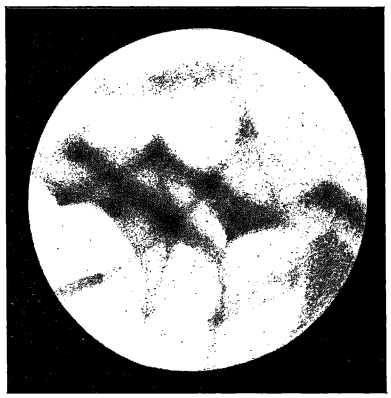

Fig. 20
Trumpler 252° E

Fig. 23
Wilson 304° F

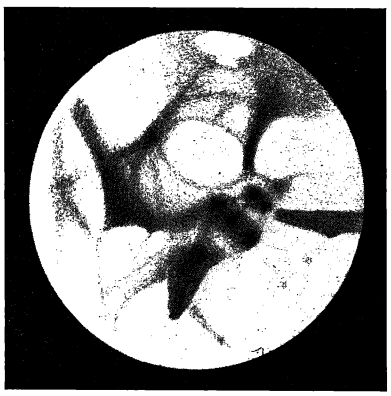

Fig. 24
Trumpler 300° F

DRAWINGS OF MARS IN 1924.

the planet at $11^h\ 52^m$ G.M.T., and had noted nothing peculiar about it, but at $12^h\ 18^m$, longitude of central meridian ω 209°.3, Hamilton came and reported a deep black notch in the terminator. An immediate examination showed not only a very conspicuous notch, but also a much less conspicuous projecting cloud immediately to the north of it (see

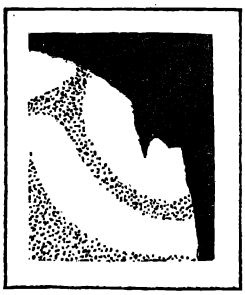

FIG. 25.
October 20, 1924.

Figure 25). The striking feature of the notch besides its depth, which was about 1″, diameter of the planet 16″.1, was its intense blackness, which I compared to that of the sky back of the planet, and Hamilton to the region beyond the terminator. It appeared to have received no sunlight whatever. Such a marking could only be a shadow, which we saw over the edge of the cloud casting it. As Hellas advanced onto the disk the notch gradually disappeared, as did the cloud following it soon after, but the curious feature was that the notch, while growing less deep, remained attached to the terminator. The phenomenon continued visible for two hours, corresponding to a rotation of the planet through 30°. Hellas extends from 275° to 310° of longitude. The notch began and ended approximately with the time that Hellas was crossing the terminator. It was also seen on the evening of October 21, when it was recorded as "very small," and on October 23, 24, and finally on October 27 at $15^h\ 27^m$, ω 189°.0. It was not visible on the nights of October 18, 19, 28, 29, or 30. The center of Hellas is in latitude 40°, longitude 292°, and its diameter, which is believed to vary, is about 1000 miles.

There can I believe be no question but that the projection on the terminator described by Dr. Van Biesbroeck in POPULAR ASTRONOMY, 1924, **32**, 589, is identical with the one described here. He saw it upon October 27, but not upon the next night. We made the same observation. He watched it until $16^h\ 50^m$. Our last record of it is $15^h\ 27^m$. This is natural, since the Yerkes Observatory is nearly an hour west of ours. Our drawings appear quite unlike, but the difference largely disappears on reading his description, in which he states that the space between the terminator and the cusp, which he represents in his drawing, perhaps quite naturally, as white, "appears as dark as the shadow side of the planet." He represents the notch as much less deep than as shown in my drawing, but my drawing, which agrees closely with

Hamilton's made at the same time, was made just a week earlier than his, and the notch became much more shallow as the days passed. Indeed on the last day of its visibility, Hamilton drew it of exactly the same depth as Van Biesbroeck, but much shorter.

The only marked difference between our observations lies in the latitude of the notch. According to Van Biesbroeck the latitude of the center on October 27 changed from —18° to —27°. We detected no change in latitude. Throughout the week of our observations its center remained constantly in latitude —40°. This we determined by measures made on October 20 and 27, both of which gave the same value, —40°.4. Our drawings upon the other nights gave obviously the same result. We also identified it at its beginning with the well known region of Hellas in which it started, and with whose central parallel it continued to coincide. This parallel lies in latitude —40°. The center of the notch is a little indefinite, and latitudes measured on the limb or terminator are less accurate than those measured on the central meridian, but we do not think we can be far wrong in our measures. The mean longitude of the crack on the terminator at our first view of it on October 20 was 287°, and at our last on October 27, 236°. In the mean time the middle of the cloud shadow had therefore shifted due east over Ausonia a distance of 51° of longitude, or 1400 miles. This is at the rate of 200 miles a day, or 8.5 miles per hour. The direction is what we should have expected in a temperate latitude, but the velocity is only one-third of what we usually find upon our planet. It should be mentioned that the solar longitude on the date of the first appearance of the shadow was 279°.0, corresponding to the Martian Date December 26. It must be recalled however that it occurred in the southern hemisphere of Mars, therefore it corresponded not to a winter, but to a summer storm.

The intense blackness of the notch, which struck all observers, we attribute to moistened ground in shadow, in other words to a continuous rainstorm, which was able to advance for some reason in these longitudes beyond the terminator, instead of being confined to the night side of the planet, as we have always believed and stated heretofore was the case. It is quite possible, however, that black markings such as this are not uncommon beneath terminator clouds, and that the peculiarity of this one consisted merely in the fact that the clouds over Hellas parted, and permitted the moistened unillumined area to be seen through a break in them. The length of the notch measured towards the central meridian on October 20, according both to Hamilton's drawings and mine was 13°.6 of longitude, or 380 miles. This curious shadow, and also its seven days' duration, we believe to be unique among observations of the planet, and we are very glad indeed to have Dr. Van Biesbroeck's confirmation of our work. As far as we are aware, the phenomenon was seen only in Jamaica and at the Yerkes Observatory.

Private Observatory, Mandeville, Jamaica, B.W.I.
January 13, 1926.